ITR: 3D Microstructure/Property Investigation of Open-Cell Polymer Foams

Gerald T. Seidler, University of Washington, DMR-0218871

Polymer foams, have widespread applications as construction, filtration, aerospace, military, and consumer products. However, existing models of the relationship between microstructure and macroscopic properties are highly oversimplified. We are using synchrotron microtomography to characterize the real 3-D microstructure of commercial and research polymer foams. Such information will form the basis for extensive computational studies of the relationship between real microstructural disorder and gross elastic properties.

After our first year, we have made solid progress in DMR-0218871. We have now collected nearly a TByte of structural data on approximately a dozen foam samples covering a range of microstructures and mechanical properties. This data is now being analyzed, and used for data-initiated simulations. One of our goals is that this data will be useful not only in our own short-term work, but will also be a testbed for development of better algorithms for finite-element analysis and computer vision. Hence, we are please that Dr. Bernd Schlei, LANL, has begun using our data as a test-case for his new algorithms in computer vision.

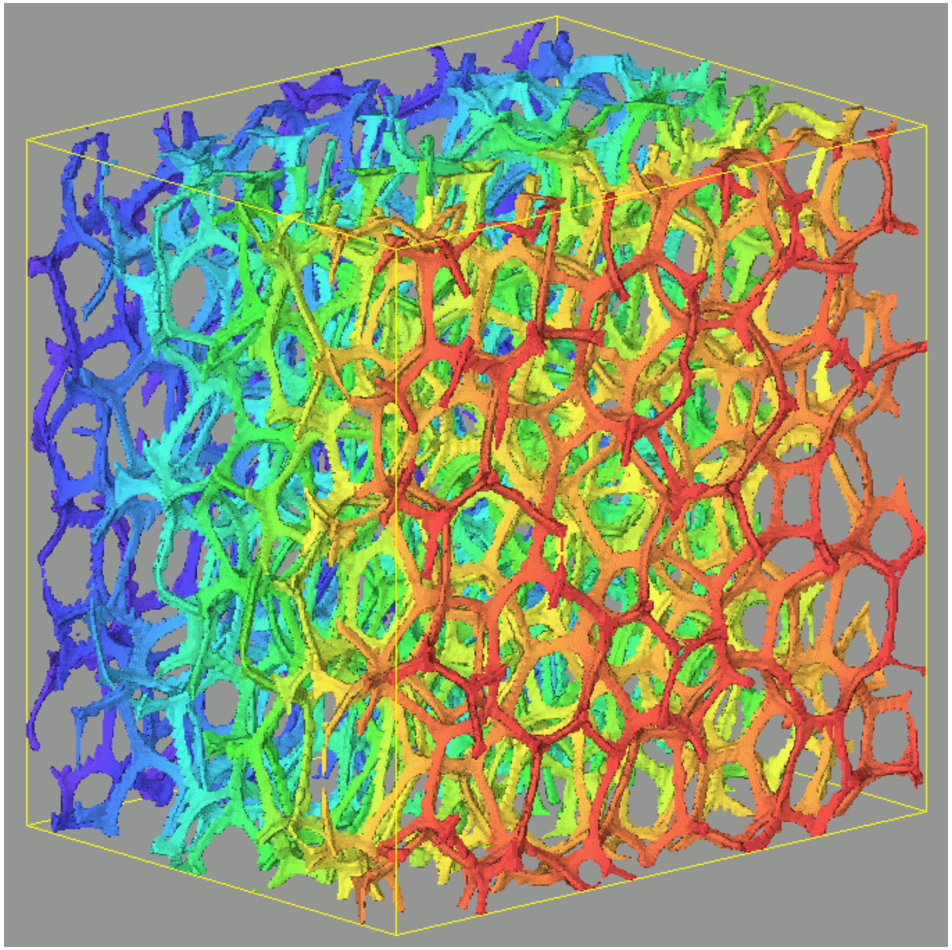


Figure: An enhanced surface rendering of an open-cellular polymer foam. The data is from our group, the advanced algorithm used for the statistically-optimized surface location is from Dr. Bernd Schlei, LANL. Dr. Schlei is using our data as a testbed for his new algorithms.

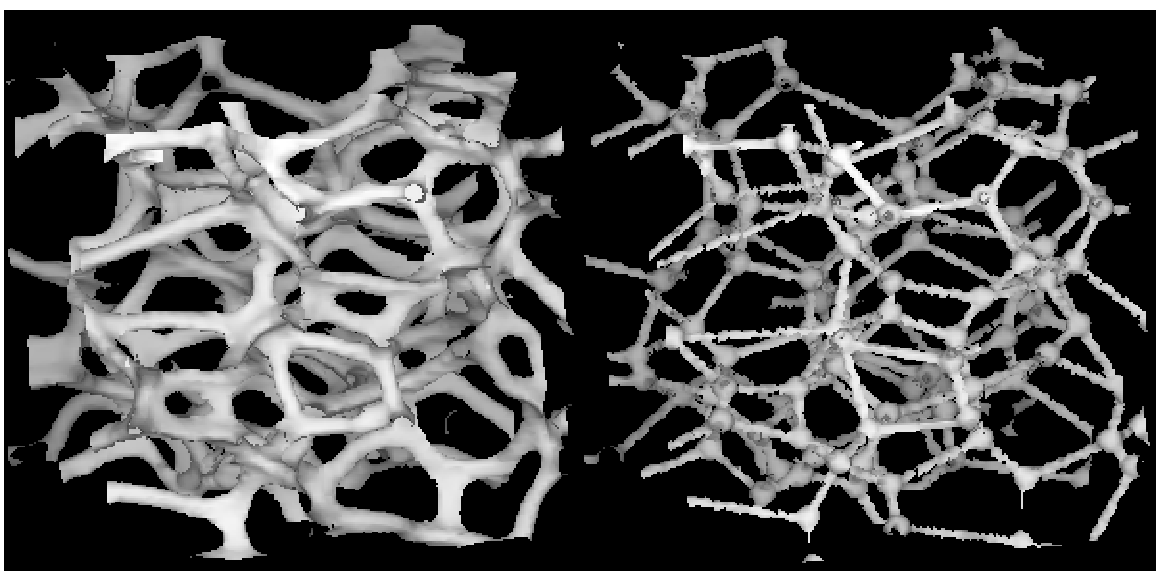
ITR: 3D Microstructure/Property Investigation of Open-Cell Polymer Foams

Gerald T. Seidler, University of Washington, DMR-0218871

Outreach and Education: We are in the process of implementing a web-based public library which will link 3-D microstructures, polymer foam properties, and finite-element grids.

This website, which will soon be posted, will include a lay-level discussion of many aspects of foam materials, including: economic impact, applications, basic physics and microstructure of cellular solids, and extensive interactive 3-D visualization tools applied to real foam microstructures which occur in everyday life. UW Physics, Applied Math, and Computer Science undergrads are centrally involved in data collection, analysis, and modeling. The figure below shows some work done by a UW physics undergraduate to teach a computer to identify the vertex-and-edge morphology of open-cell polymer foams. The infrastructure for this project has now been completed and a two papers are in preparation.

Student involvement: 6 undergraduates (5 physics/CS, 1 journalism), 1 grad student



Left: volume rendering of a small region of polyurethane foam, as is commonly used in shock absorption in consumer products.

Right: the result of computer vision software for identification of the vertex-and-edge morphology of open cell foams. This model is useful for statistical characterization of the microstructure and for finite-element simulations.